Sec'y of the Territory

## DEPARTMENT OF

# Geology and Natural History

1903

LABOR OMNIA VINCIT
GRAND SEAL TERRITORY OF OKLAHOMA.

1904

# THIRD BIENNIAL REPORT

A. H. VAN VLEET : : : TERRITORIAL GEOLOGIST

# DEPARTMENT OF
# GEOLOGY AND NATURAL HISTORY

## TERRITORY OF OKLAHOMA

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# THIRD BIENNIAL REPORT

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## Contributors to Present Report

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Eck Frank Schramm.

# LETTER OF TRANSMITTAL

Territory of Oklahoma,
Department of Geology and Natural History.

Hon. Thompson B. Ferguson, Governor of Oklahoma.

Sir: In compliance with the requirements of section five of an act of the Fifth Assembly of the Legislature of Oklahoma establishing the department of Geology and Natural History, I have the honor to submit the second biennial report.

The report deals almost exclusively with problems of present economic interest.

The great interest in the Wichita Mountains, and the lack of any reliable literature on the subject, seemed to warrant a thorough investigation of this region. This has been done in so far as time and funds would permit.

The building stone of a state is always regarded as one of its most important products, and this alone would demand as early and as complete an investigation as possible; but the recent good-roads movement has made a knowledge of the resources of our Territory, in regard to stone suitable for building material, road material, and construction work of various kinds, imperative.

The contact of the Permian with the Pennsylvanian is a problem that has engaged the attention of the best geologists for years. The report on this subject is, however, not only of great scientific interest, but it deals largely with the economic phases of the region under investigation.

In addition, much preliminary work has been done on the clays, shales and salt of Oklahoma, and valuable collections made in Botany and Zoology. These collections are not yet classified and arranged so as to make a report at this time possible.

The work has been accomplished under adverse conditions, both as to available time and funds. It is hoped, nevertheless, that the results will prove of interest and value.

Very respectfully,
A. H. VAN VLEET, Territorial Geologist.

University of Oklahoma, December 5, 1904.

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# A Preliminary Report on the Contact of the Permian With the Pennsylvanian In Oklahoma.

BY CHARLES TOWNSEND KIRK.

## INTRODUCTION.

The Oklahoma Geological Survey has ever accomodated itself to the most urgent economic needs. But little work with purely a geologic purpose has been done in this interesting and important field. In the Biennial Report of two years ago, the western half of Oklahoma was in the main the field of investigation. The gypsum of that region, which has become known as one of the most important deposits of its kind in the world, was first discussed comprehensively in that publication by Prof. Chas. N. Gould.* For the past fifteen years another most urgent need has been the development of Oklahoma's gas, oil and coal fields.

The first point in this problem would seem rationally to be a definition of regional boundaries. In the states of Kansas on the north and Texas on the south the question has been partially solved and the western limits of the Coal Measures, or Pennsylvanian rocks, traced to the boundary line of Oklahoma on the north and to the Indian Territory on the south.** Before these regions were exploited the possibilities for gas, oil and coal along the contact in these states were largely hazardous.

During the summer of 1904 the writer was commissioned to trace this line of contact from a known outcrop in the Little Beaver Valley, Kaw Nation, across Oklahoma to the South Canadian River. Besides the investigation of this geologic problem he was expected to report upon the physiographic conditions and economic possibilities of the region traversed. In following this contact it was hoped that the question as to whether the limestones of Kansas and Texas, which have coincident strikes, are continuous throughout the Red Beds, would be solved.

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*Second Biennial Rep., Terr. of Okla. 1901-1902, p. 75.

**A recent paper, 1903, by Dr. Geo. I. Adams on the Relations of the Limestones of Kansas and Texas to the Red Beds. Title unknown.

The area previously in doubt has rather a broad extent through Oklahoma, especially at the south. At the north where limestones and fossils abound, the line of contact was more definitely known. But beginning considerably north of the Arkansas River, the sandstones appear, and just south of that stream the Red Beds become very pronounced. Owing to the uniformity of color and structure and the absence of fossils in these Red Beds, on both sides of the Pennsylvanian-Permian border line, the exact line of contact was thought to be difficult to ascertain. The contact between the Pennsylvanian rocks, those usually carrying carboniferous deposits, and the Permian, those rarely yielding such products, was believed to be in a belt extending somewhat irregularly southwestward from the valley of Little Beaver Creek, Kaw Nation, to a point on the South Canadian River some three miles southwest of Norman, Oklahoma. This area of probability stretches across parts of Kay, Noble, Pawnee, Payne, Logan, Lincoln, Oklahoma and Cleveland counties. Although the geology and paleontology of the northern or limestone portion has been well marked out,* no persistent attempt has been made until recently to trace the line through the sandstone area of this field.

As in previous surveys the work has been handicapped both by lack of funds and by the absence of contour and other accurate geological maps. On the appropriations allowed only a small party could be put in the field and this must needs work altitudes, and even meanders in some instances, largely by estimation. The work of Prof. Chas. S. Prosser,* that of Dr. Geo. I. Adams,** and of Mr. F. W. Cragin,*** have been made use of freely in instituting and correlating the work. The personal suggestions of Prof. Chas. N. Gould and Mr. E. G. Woodruff have been invaluable.

## PHYSIOGRAPHY.

In discussing the contact it seems best to consider the region in two physiographic provinces; the northern or limestone and the southern or sandstone provinces. These differ markedly in many respects, obviously so in topography.

In the Kaw and Osage nations, the country north and east of the Arkansas River, the mesa-canyon aspect is prevalent. In this area is comprised the foot-hills of the "Permian Mountains," as Prof. Broad-head has called the "Flint Hills" of Kansas. The alternating shales and sandstones have been dissected by the streams and fashioned into table-lands, buttes, and grotesque knobs. The inclines from these prominences are not rock-strewn, as might be supposed. A limestone disintegrates readily in a climate as humid as the "second bottom" of theArkansas, so that instead of being talus slopes, the hill-sides are grassy meadows. Timber grows only closely along the streams.

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*"The Classification of the Upper Paleozoic Rocks of Central Kansas," by Chas. S. Prosser, Jour. Geol. Vol. III, No. 7, Oct.-Nov., 1895. "Revised Classification of the Upper Paleozoic Formations of Kansas," by C. S. Prosser, Jour. Geol. Vol. X, No. 7, Oct.-Nov., 1902.

**Stratigraphy and Paleontology of the Upper Carboniferous Rocks of the Kansas Section," Bulletin No. 211, U. S. G. S., pp. 1-72.

***Colorado College Studies, Vol. VI, March, 1896.

Toward the south the surface appearance is remarkably different. Instead of sharply etched limestone table lands, well worn sandstone ridges abound. Here and there veins of ferruginous sandstone stand out. No continuity of heights is observable; no regularity of erosion exists. The transition is by no means abrupt, however. The trenched prairie mesas of the northern provinces grade into the rough, wooded knobs and divides of the southern. The timber here is not confined to the narrow valley, but grows almost continuously along the contact from the Deep Fork to the South Canadian.

In crossing this region from west to east it may be seen that in the contact belt defined above, the rolling shale topography of the Permian on the west is passing into the broken limestone and sandstone hills in the east. Roughly speaking, this line of Pennsylvanian-Permian contact is the eastern boundary through Kansas and Oklahoma of the "Great Western Plains."

Despite the fact that the general surface slope is almost due north, the northwesterly dip, especially in the limestone province, is such as to turn the line of strike to the west of south. The drainage system is governed to some extent by this arrangement of the beds. The major streams have succeeded in cutting across the strata, but in general the minor water ways still follow the strike. A glance at the map of eastern Oklahoma will show this tendency and suggest that the major streams are superimposed while the newer minor systems are consequent upon the formations.

## STRATIGRAPHY.

The limestone and sandstone provinces pass into each other stratigraphically even more gradually than physiographically. A section across the strata near the contact at the northern line of Oklahoma reveals sandstone members 2 to 4 feet thick on both sides of the Wreford or bottom formation of the Permian. From this point southward the sandstone so thickens and replaces the limestone that in the Black Bear Valley, 50 miles south of Kansas, the Wreford is a three-foot ledge hardly different from the non-fossiliferous sandstone which lies abundant south of the Black Bear.

On account of this gradation or merging into one another of the limestones and the sandstones, and the presence of sandstone in the beds even north of the Oklahoma-Kansas line, no line of demarkation can be drawn across the Pennsylvanian-Permian contact to separate the limestone from the sandstone provinces in Oklahoma.

It is evident that these sandstones have a silicious effect upon the limestones even as far north as above the southern Kansas line. Prof. Prosser* has described the Wreford of Kansas as a formation about 35 feet thick,** composed of three strata, a cherty limestone below and above separated by a heavy limestone nearly free from flint. With the exception of thickness this is a good description of the Wreford in the Kaw Nation. Near the Kansas-Oklahoma line the formation is only 20 feet thick; at the mouth of Beaver Creek, Kaw Nation, it measures 12 feet, while about 4 miles west of Glencoe, Payne Co., Okla., where it has lost almost all the appearances of limestone, the ledge is scarcely 4 feet thick. A similar discussion may be made of the other limestones running south from the "Flint Hills" of Kansas. All traces of the Cottonwoon disappear about the northern Oklahoma line; the Pawhuska a ledge 630 feet below the Cottonwood in Kansas, * * * persists as far south as Sparks, Oklahoma, in the valley of the Deep Fork of the Canadian; another limestone above and running parallel to the Wreford, touches the Indian Meridian at a point about 10 miles southeast of Perry, Oklahoma. It is thought to correspond to the Fort Riley, but the outcrop was not traced from a known exposure of that ledge nor was a section of the intervening strata taken. From this it may be seen that the limestones are losing their identity and are disappearing between the sandstones toward the south, as though being eaten away from below and above.

As it is usually indicated the boundary between the red and gray formations is not nearly as far north as the northern Oklahoma line. In the broad belt of gradation between the limestone and sandstone provinces, however, that limit may be shifted considerably without gross error.

The above observations confirm the belief that the Red Beds interlap with both the Permian and the Pennsylvanian. The contact, then, extends through the Red Beds, leaving a large area of these in the Carboniferous to the eastward. This embayment of red shales and

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*Journal Geol., Vol., X, No. 7, Oct.-Nov., 1902, p. 713.

**Cottonwood Falls Folio, No. 109, U. S. G., p. 3.

***Geo. I. Adams, U. S. G., Bull. 211, pp. 64-66.

sandstones into the Coal Measures forms an irregular segment reaching 250 miles in length and 50 miles in width. This group of rocks has been known provisionally as the Chandler, from a town of that name in its midst, but as the area has no independent place in the geologic scale probably the name will not be retained for it.

The softer members of the northern province of contact are the drab clays and shales which are also the thicker beds. In the Kaw Nation the reddish gray shale immediately below the Wreford is quite uniformly 40 feet thick; that just above runs from 10 to 15 feet. In the northern region the shales between the Pawhuska and Wreford carry irregular beds of sandstone varying from about 4 feet thick in the northern Kaw and Osage nations to some 15 or 20 feet at Pawnee, Oklahoma. After passing into the Red Beds proper the geology is somewhat irregular. No faults or uncomformities exist, but thickenings, thinnings, lenses and local dips are prevalent everywhere.

The sandstone ledge observed to be a continuation of the Wreford is best exposed on the bluffs of the Cimarron River in Payne County. It is thought well, therefore, to adopt the name Payne for this formation in the Red Beds. During its entire extent in Oklahoma, the Payne contains an unusual amount of ferric iron. Here and there the structure is roughly nodular, but again it is so smoothly bedded as to furnish excellent construction stone. But few examples of cross-bedding are to be found. In many places, notably in the Stillwater Valley, the formation is known as "iron rock," from its red and almost vitrified appearance due to the ferric oxide. No faunal fossils have been found in it. These lithologic conditions seem to justify the name Payne and not the retention of the name Wreford for this locally peculiar formation. The conspicuous thickening in the Cimarron Valley is not confined to the Payne, indeed the basin contains remarkably heavy ledges of all the sandstones crossing it with a corresponding thinning and pinching out of the clay members. The writer has approximated this section along the Cimarron River between Ripley and Perkins. Top:

| | |
|---|---|
| Red shale with bands of gray | 10 feet |
| Red, loose-bedded sandstone | 12 feet |
| Traces of clay | 0 to 1-2 feet |
| Red, ferruginous sandstone, the Payne | 15 feet |
| Red, loose sandstone, somewhat calcareous below | 8 (?) feet |
| Silicious sandstone, fossils, the Pawhuska | 6 (?) feet |

It has been shown above that the Wreford section thins southward into the region where it disappears into the Payne. From the above section it may be seen that the Payne is much thicker in this basin than in the region of its beginning. As far as the Cimarron Valley this thickening is somewhat uniform; south of that stream, however, the Payne runs more irregular. For example, on the Cimarron-Deep Fork Divide, one well passes through it as a 30 foot member with red shale on both sides, while a well a mile south finds it only 10 feet thick with the shale beds above and below correspondingly thicker than in the first well. Similar observations were made at natural exposures along the creeks.

After crossing the divide just mentioned the contact formation strikes into the black jacks and sand hills. It must be mentioned that the altitude of the surface increases toward the south, the Canadian drainage basins being the highest, for the same longitude, in Oklahoma. Probably on account of this altitude there appears south of the Deep Fork a thin sandstone which does not overlap either the Payne or the Wreford in the lower lands to the north. It is this ledge which lies at the surface in the eastern edge of the black jacks through Oklahoma and Cleveland counties. Between it and the Payne is a clay member varying from 15 to 40 feet in thickness. Although in general the sandstones are difficult to distinguish on account of the absence of fossils and the similarity of structure and appearance, the ledge just mentioned is somewhat different from the Payne. Besides being thinner it carries a mass of peculiar concretions commonly called "petrified roses."* As this higher ledge is most pronounced in Cleveland County, the name Norman,** the county seat of that county, is suggested for it. It lies well exposed on the hill tops six miles southeast of Norman, and again on the bluffs at Purcell, I. T. The author thinks that the 12 foot sandstone (seen in the Cimarron section) which is shown as separated from the Payne by an occasional thin seam of clay, is probably either a thickening of the Payne or a local lens, and has no connection with the Norman. The clay member between the Payne and Norman is so similar to other clays of the Red Beds that no identical name and description will be given it. It has the same geologic position as the Matfield shale of the Kansas section, but partakes of almost none of its properties.

## DIP AND STRIKE.

As has been pointed out already, the dip of the rocks along the contact is toward the west. This pitch is less in the sandstone country than among the limestones. Along Black Bear Creek and the Cimarron

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*The nature of these and other concretions is now being investigated by the writer in the University of Oklahoma and will be discussed in a future paper.

**This term was used formerly for a larger division of the Red Beds as discussed by Prof. C. N. Gould, but that use of "Norman" has been dropped.

River, the inclination is, in places, almost nothing, but in general it is about 8 feet per mile as against twice that dip among the limestones in southern Kansas. This unconformity in dip in the two regions has led some students interested in the problem, to the assumption that the Red Beds of Oklahoma represent what was formerly a low, flat beach lying unconformably upon the limestones which appear to the north and south of it with coincident strikes. Close observation among the exposures in Oklahoma, however, lead to different conclusions as discussed above; i. e., that the limestones show a transition into these sandstones and that no unconformities exist.

Where the major streams cross the contact strike, good opportunities for section and dip measurement are offered. As noted above, the best exposures were found in the Cimarron Valley.

Where the contact crosses the North Canadian River in the black jacks sand hills northwest of Jones, the formations are masked by deposits of sand from above, but a massive ledge shows to some extent in the bed of the river. Following south into Cleveland county a clean cut exposure is found in the channel of Little River, 7 miles northeast of Norman. The ledge appears again in the South Canadian near Noble, Oklahoma, and somewhat higher in the same stream at Purcell, I. T. After crossing this river the trend of the outcrop is apparently more to the southwest, but was not followed far into the Chickasaw Nation.

In the Kansas section the Wreford has been found to be the bottom formation of the Permian.* As the Payne has been ascertained by the writer to be a continuation of the Wreford, the bottom of the Payne is seen to be the horizon of contact of the Pennsylvania-Permian rocks in the Red Beds.

When a general survey of this region is made the formation below and above may be correlated and defined accurately as to local dips, "pinchings out" and other evidences of small unconformities. With the data in hand at present this cannot be done. Diligent search was kept up during the entire traverse for fossils in the Red Beds south of the limestone along the contact, but none were discovered. Those most persistent in the Wreford as it thinned southward were: Archiocideris sp., Strophostylus nanus (?) and Myalina swallowis (?). Owing to the scarcity of the specimens and the poorness of their preservation the species are uncertain.

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*C. S. Prosser and J. W. Beede, U. S. G. S., Folio No. 109, p. 6, and C. S. Prosser, Jour. Geol., Vol. X, No. 7, Oct.-Nov. 1902, chart opp. p. 718.

The line of contact between the Coal Measures and the Permian rocks was traced from the prominent exposures low in the valley of the Little Beaver, Kaw Nation; it appears along the bluffs across the Arkansas River from Kaw, Kaw County, traverses the "Horse Shoe Bend" of the Arkansas in the Osage nation and passes into Noble County at the mouth of Turkey Creek. Thence it was followed up Greasy Creek, Otoe Nation, and across the Arkansas-Black Bear Divide, crossing the Black Bear about 2 miles east of Morrison. Near the top of the Black Bear-Stillwater Divide, 4 miles west of Glencoe, Payne County, the limestone characteristics of the Wreford disappear entirely. This is the southern limit of the Wreford and the northern limit of the Payne. Ledges of the Payne are conspicuous to the west of Stillwater. The formation leaves Payne County about two miles west of Perkins, though its base lies to the east of that town, bears southwest past Fallis, Lincoln County, and crosses the Oklahoma-Lincoln County line east of Luther. Though covered by much sand in this region, it was observed to outcrop in the North Canadian River northwest of Jones, strike toward Choctaw and appear prominently in the less sandy country at the head of Little River in Cleveland County, whence it was traced continuously to Purcell.

## ECONOMIC PRODUCTS.

Stones.—On acount of a preponderance of chert, the Wreford is of minor importance as a building stone. Although that formation is drawn upon to some extent locally, the Fort Riley(?) and Pawhuska are used more extensively for construction, flagstones and fence posts. The thin-bedded, silicious Wreford, however, is excellent for ballast and rip-rap on high-roads and railroads. South of the transition this ledge contains some valuable sandstone quarries. These are found usually on the broader divides, notably between Black Bear and Stillwater creeks. Wherever the Payne outcrops, it usually affords a fine-grain stone nearly free from cross-bedding. At the base of a thickening, however, it is sometimes concretionary with iron nodules.

Other deposits:—

Carboniferous.—Reports from deep well borings indicate that coal is struck along this contact in Oklahoma at from 600 to 900 feet, though at the present writing none has been mined. Judging from this reported depth and the dip of the Red Beds strata, it is probable that coal lies at less than 2,000 feet from the surface at a distance of 50 miles west of the contact. It is known, however, that local seams of coal are present in the Permian and in the Pennsylvanian, so that until the contact region is further exploited toward the south, no accurate estimate can be made in that region from drilling results. The best strikes of gas and oil have been made in the north in the limestone province, but there are no good reasons why the same conditions do nct exist farther south and west with the possible exception of added depth.

Brick clay.—The brick material of the southern province is abundant and wide spread. That of the north is not accounted so good. The Red Beds shales furnish a product fine in color with enough alkali for fluxing and sufficient sand for vitrifying when enough heat is applied. A lenticular seam of potter's clay is reported from northwest of Chandler in the clay member next below the Payne sandstone. With the possibilities of cheap fuel near at hand it may be prophesied that in this region the brick industry may become very highly developed.

Cement.—While there is no gypsum in this immediate region there are abundant materials for Portland cement. Although no analysis has been made, to the writer's knowledge, of these limestones, there are no visible evidences of magnesia in them. An abundance of alumnia exists in the clay in both the limestone and sandstone regions. When the fuel problem is solved the necessary high heat to cause a "clinkering" or semi-vitrifaction of these products can easily be obtained.*

Soils.—The soil of this region is a loam underlain either by sandstone or shale or immediately by a joint clay. A sandy soil is not only pervious to water but tends to resist evaporation, and when underbedded by an impervious stratum it offers the ideal condition for catching and conserving moisture. These conditions exist almost universally in this belt of shale-sandstone transition, and have produced vegetation and decay to provide a soil rich in organic mold and more than usually fertile. This fertility of soil, especially in the middle and northern regions, has had much to do with its exceptional development as an agricultural area. Excepting far to the south where wheat is grown extensively, the farm products are corn, cotton, broom-corn, cats, alfalfa, cane, millet and some wheat, rye and barley.

Sand.—The sand in the black jacks is usually too highly colored or too fine in grain for plastering purposes. That along the larger streams has been leached of its coloring matter and where not blown about nor subjected to the grinding action of water currents, it is suitable for plastering and cement.

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*The Portland and other cement possibilities of Oklahoma are now under investigation in the University laboratories.

## VEGETATION.

As was noted above the timber at the north is confined to the stream banks. This restriction obtains rather generally as far south as the northern slopes of the Deep Fork Valley. On the higher ridges of this basin there are extensive growths of caks and black jacks, but lower in the valley there are elms, cottonwoods, willows and the like. Much of the timber is large enough for the saw, many trees being long enough for three 10 foot cuts; others are used for piling, while material for fence posts and fire wood will be abundant for years to come. Wherever the sandstone is mixed with clay on the ridges, post oak and hickory is found, but in the purely sandstone area black jacks grow without interruption. The belt contains no sassafras nor sweet-gum, which grow farther east. A few evergreens, cedars, grow in the South Canadian Valley. The grass on the prairie and in the open timber is blue stem or bunch grass, fine for hay or pasture.

## WATER SUPPLY.

The belt of country under discussion has a bountiful rain fall. At the south this is above 20 inches annually, and at the north it is more than 30 inches for the same period.* This amount of water falling on the kind of soil discussed above, insures a sufficient supply for all practical purposes.

At the north there are few intermittent streams. Nearly all are fed perennially by springs. A representative of these is "Big Spring" in the Little Beaver Valley. The formation at the spring is an impervious clay overlain by a porous limestone. The discharge is normally about 25 second inches, which amount is much increased by similiar rills before reaching the creek two miles away. In the sandstone province there are hundreds of small springs, most of which the merely seeps. The "Dripping Springs" in the Otoe Nation are the largest of these visited by the author.

Some of these sandstone springs exude bog iron ore, a product of iron and sulphur, which, on account of its greasy appearance, is often mistaken for petroleum.

These numerous discharges of underground water are sure indications of a high-water-table occasioned by the bountiful precipitation already mentioned.

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*Ann. Summary, 1903, Okla., Sec. U. S. Weather Bureau, C. M. Strong, Oklahoma, Okla.

# Geology of the Wichita Mountains of Oklahoma.

By Charles Newton Gould.

The oldest rocks in Oklahoma are the Wichita Mountains in the southwestern part of the territory. These mountains are composed chiefly of three classes of igneous, or unstratified rocks, granite, gabbro and porphyry; and three classes of sedimentary or stratified rocks, belonging to Lower Palaeozoic formations, the Reagan sandstone, the Arbuckle limestone, and the Viola limestone. Granite which predominates composes probably two thirds of all the rocks of the range.

Extending across the southern part of the Great Plains there are three groups of mountains, very similar in formation and apparently of the some geological age. They are the Ouachita group in Arkansas and the Choctaw Nation; the Arbuckle Mountains in the Chickasaw Nation; and the Wichita Mountains in southwestern Oklahoma. Each group consists of a core or nucleus of igneous rock, chiefly granite, prophyry, gabbro, basalt, and the like, around which are flanked succeeding layers of stratified rocks, limestones, conglomerates, sandstones, clays and shales. In some former geological age these groups of mountains have been raised like gigantic blisters on the surface of the earth; shoved up from below by some great subterranean earth movement. Since that time the agents of erosion, wind, rain, frost and gravity, and the rest of nature's workmen, have been busy planing down these domes until in some places they have all been carried away. In other cases, as for example in the Arbuckles, erosion has succeeded in removing only part of the sedimentary rocks, and exposing here and there a peak of granite or porphyry, of which East Timbered Hills, West Timbered Hills and the Granite Hills at Tishomingo are examples.

In the Wichitas the rocks do not differ materially from those in the Arbuckle and Ouachita mountains farther east. Erosion has cut down much farther, however, and here the sedimentary limestone and sandstone has nearly all been removed and the main part of the ranges consist of jagged peaks of granite and porphyry. Around the sides of the mountains there are remnants of limestone ledges which in former times extended as a dome over the tops of the granite mountains.

These rocks have been named and described by Mr. Joseph A. Taff, to whose recent publication, Professional Paper No. 31, U. S. Geological Survey, the reader is referred.

The extreme length of the Wichita Mountains, from the Carlton Mounds on Medicine Bluff Creek near Fort Sill, Comanche County, to the last granite hill that disappears under the high prairie 5 miles west of Headquarters Mountain at Granite, Greer County, is 65 miles. The extreme width, from Rainy Mountain to the southwestern granite butte on the North Fork of the Red River, 6 miles southwest of Navajoe, is 30 miles. It must be understood, however, that the Wichitas are not continuous throughout this area, for, in fact, the mountains consist chiefly of scattered ranges, peaks, and short chains, the bases of which are buried beneath the surrounding and intervening plains. They may be regarded as buried mountains projecting their tops above the surrounding plain. .

## PHYSIOGRAPHY.

The Wichita Mountains may be divided into three general groups as follows: First, the main range; second, scattered groups and peaks in the western part of the area; and third, a row of hills composed chiefly of limestone, which parallels the main range on the north and east. These three groups will be discussed briefly.

The main range of the Wichitas, the width of which will average 10 miles, extends northwest from the region of Fort Sill for a distance of about 30 miles, to the vicinity of Saddle Mountain and Mount Baker just east of the headwaters of East Otter Creek. This part of the range is practically continuous throughout and is composed chiefly of rugged peaks of granite, the highest of which, Mount Scott and Mount Sheridan, are each about 1200 feet above the plain. There are in fact two ranges running parallel northwest and southeast, and separated by a distinct intermontane valley, from 1 to 4 miles wide, extending the entire length of the ranges. The streams draining this valley flow east and south and escape to the plain through gaps in the mountains. East of this main range, there are a number of outlying peaks and short ranges, some of which attain an altitude of 800 feet or more.

West of the main range of the Wichitas, which, it must be remembered, is divided into two general ridges, there are scattered groups, peaks and low ridges extending to a point a few miles beyond Granite, Greer County, a distance of 40 miles from Mount Baker. Some of these peaks and ranges have received characteristic names; for instance, the term Raggedy Mountains is applied to a group of scattered, roughly outlined ridges and peaks lying along the heads of the various branches of Otter Creek; Long Horn Mountain is near the head of Middle Otter; Dome Mountain, Tepee Mountain, Elk Mountain, Little Bow, and others lie near Elk Creek; Devil's Canyon Mountain is 6 miles long and lies in a bend of the North Fork of the Red River; Navajoe, Quartz, and Headquarters mountains lie in Greer County west of the North Fork of the Red River which winds in and out among the granite peaks.

Running paralled to the granite ranges on the northeast, from a point 7 miles north of Fort Sill to Rainy Mountain, a distance of 30 miles to the northwest, is a row of limestone hills which, like the main range of the Wichitas, consist of ranges, peaks and scattered knobs. The longest range, 16 miles in length, will average 2 miles in width. Near the head of Blue Creek Canyon, 8 miles north of Mount Scott, the range of limestone hills divides into two parts, one range trending approximately north 70 degrees west and the other north 40 degrees west. Both ranges finally run out into a series of peaks and knobs which gradually disappear under the level plain.

These limestone hills, like the granite mountains, are but the tops of buried ranges. Standing upon the summit of almost any one of the hills and looking off over the broad plain, one can, with a very slight effort of the imagination, detect all sorts of sea coast phenomena. At the bases of the hills are gulfs and peninsulas, coves and capes, isthmuses, straits and islands, all petrified, as it were, but easy to be distinguished. The rock comprising the plain around and between the mountains is much younger than the mountains themselves, that is, it was deposited at a much later period in the earth's history. The whole Wichita Mountain system with the flanking limestone hills may be regarder as a group of islands in a sea of plain composed of much younger rocks, which make up the greater part of the formations between the Mississippi and the Rockies. Other similar islands constitute the Arbuckles in the Chickasaw Nation, the Ouachitas in the Choctaw Nation and Arkansas, the high peaks of the Ozarks in Missouri and the rocks of the Central Mineral Region in Texas.

## GABBRO.

Of the three chief varities of igneous rocks in the Wichitas, the gabbro, which is an igneous rock belonging to the basalt family, made up largely of plagicclase, feldspar, and pryoxene, is probably the oldest. The gabbro of the Wichitas is typically a hard, black, crystalline rock, sometimes known to the miners of the mountains as black granite; it frequently has a greenish tint, or again it may be grayish in color, and often weathers into rough, lumpy surfaces. It is sometimes cut by dikes composed of various minerals, quartz, diorite, basalt, granite, etc.

In the mountains, gabbro rocks outcrop in three separate localities, two of which are in the main range and the other west of this range. In the main range the most extensive exposure, which covers an area perhaps 2 miles wide and 12 miles long, lies along the north slope of the mountains on both sides of Medicine Bluff Creek, and extends northwest and southeast, paralleling the range from the east end of Mount Scott to the east slope of Saddle Mountain. The second gabbro exposure, some six miles long and perhaps a mile wide, is in the western part of the intermontane valley along the heads of West Cache and Quanah creeks. The gabbro in both of these localities does not as a rule present conspicuous relief, but weathers into gentle slopes and hollows with occasional low ridges and buttes. The third locality in which gabbro is found is in the central division of the Raggedy Mountains west of the main granite range. This range is 15 miles long and extends westward from near Mount Baker to a point within 3 miles of North Fork of the Red River. The average width of the range is something like three miles, and across it flow the various branches of Otter Creek. In the western part of the range there are numerous dikes and intrusions of other igneous rocks, chiefly granite and quartz.

## PORPHYRY.

In the eastern part of the main range and in certain localities among the limestone hills, the rocks consist of porphyry. This is a hard, massive rock, usually with a grayish ground-mass in which are imbedded numerous phenocraysts, or crystals, usually reddish or pinkish in color, giving a characteristic reddish-gray tint to the rock. There are three localities in which porphyry occurs, as follows:

In the Fort Sill Military Reservation and between the fort and Mount Scott the greater part of the rocks are porphyry. Signal Mountain, the Carlton Mounds, Medicine Bluff, and a number of unnamed peaks are composed of this rock. This porphyry weathers smooth, and the surface of the hills consisting of this rock, are usually grass-covered and easily distinguished from granite hills which weather into large boulders and are timber-covered. In the western part of this exposure the porphyry passes gradually into red granite so that in many places it is virtually impossible to tell where one rock disappears and the other begins.

Near the central part of the main ridge of limestone hills, at a point along Blue Creek Canyon some 6 to 8 miles north of Mount Scott, there is a second expcsure of porphyry covering an area of perhaps 8 square miles. The character of the rock in this region does not differ materially from that on the Fort Sill Reservation. In the western part of the locality the prophyry is cut off from the limestone by a fault, and in its eastern exposure where it is flanked up along the limestone ridge, it lies unconformably below the Reagan sandstone, the lowest member of the sedimentary rocks exposed in the Wichitas.

The third area of porphyritic rocks is at the northern extension of the limestone hills, which is the extreme northern part of the Wichita Mountain region. In this vicinity there are a dozen or more scattered peaks of porphyry standing out on the plain. In two instances this porphyry lies unconformably below the Reagan sandstone.

## GRANITE.

With the exception of the gabbro and porphyry just described, and a relatively few dikes, the igneous rocks of the Wichitas consist of granite, which varies in color from red to gray, with light red greatly predominating. It is cut by several series of joint planes and weathers into massive boulders. The granite is a durable building stone and in a number of localities is being quarried for this purpose. At the town of Granite, for instance, expensive machinery has been installed and the product is shipped to eastern states. The peculiar rose and pink tints render the rock particularly valuable for ornamental purposes. The high peaks of the main range, such as Mount Scott, Mount Sheridan, Mount Baker, Saddle Mountain and others, as well as all the scattered peaks west of the main range, except the gabbro range previously discussed, are composed of granite. Navajoe, Tepee, Long Horn, Devil's Canyon, Dome, Little Bow, Elk, Quartz, Twin, Headquarters and other peaks, and chains in this western grcup are all granite mountains.

## DIKES.

In many places the igneous rocks of the Wichitas have been cut by dikes. A dike is a wall of igneous rock which was forced into a fissure when molten and then consolidated. As has been stated the greater part of the rocks in the region are gabbro, porphyry and granite, of which the gabbro is the oldest. This rock perhaps more than any other, then, has been cut by dikes.

Some of the rocks which form dikes are the following: granite, porphyry, basalt, andesite, quartz, diorite, and gabbro. There are granite dikes in the gabbro and porphyry, and dikes of basalt, andesite diorite or quartz in either gabbro, porphyry or granite. These dikes vary in thickness from that of a knife blade to as much as fifty feet. In most cases the dike rock is different in color from the rock that has been cut, as for instance where red granite cuts black gabbro, or where black diorite cuts red porphyry. Not infrequently one dike cuts another and cases are known where three dikes intersect at a common point.

So far as known there are no true mineral veins in the mountains. Hundreds of dikes have been mistaken for mineral veins, however, as where a dike of red granite cuts through the black gabbro, and the red granite has been called rose quartz, and the gabbro spoken of as black granite, in which case the structure is described as a rose quartz mineral vein in black granite. Owing to this misconception the greater part of the mines in the Wichitas have been sunk along dikes, under conditions which gave no reasonable hope of obtaining anything of value.

## REAGAN SANDSTONE.

The Reagan sandstone, the oldest sedimentary rock in Oklahoma, is composed typically of coarse-grained, angular particles derived from the disintegration of porphyry rocks. There are local ledges of smooth, rounded conglomerate interstratified with shale members, but coarse sandstone makes up the greater part of these rocks. The age of this formation as indicated by Trilobites and other fossils is Middle Cambrian.

The Reagan is exposed unconformably above the Carlton porphyry and conformably below the next higher sedimentary formation, the Arbuckle limestone, at two localities; first, flanked up along the limestone hills east of Blue Creek Canyon; and second, along the side of some limestone peaks in the extreme northern part of the Mountains. At Blue Creek Canyon the Reagan is exposed for a distance of nearly 6 miles, while farther north the line of outcrop is not more than 2 miles in length; in both localities the exposure is but a few hundred feet wide. It was a ledge of greenish glauconitic clay belonging to the Reagan of this locality that in the early days of the mining excitement was known as the Star Copper Lode. The green color was supposed to indicate the presence of copper. Hundreds of mining claims were staked out along this clay bank and a man who had a slice of the Star Copper Lode was considered a prospective aristocrat. It is needless to say that these claims have all been abandoned.

## ARBUCKLE LIMESTONE.

Lying conformably above the Reagan sandstone is a limestone formation which makes up the greater part of the northern division of the Wichiitas. The limestone is hard, compact, and massive, and is in practically all places much folded and faulted. It rarely lies level but has been broken and tilted at all sorts of angles and is more often found standing on edge than in any other position. As the popular phrase has it, "the limestone looks as though it had been piled in windrows." The thickness of this formation in the Wichitas is unknown, but in the Arbuckle Mountains, Mr. Taff estimates the thickness at from 4000 to 6000 feet, and there is no reason for supposing that it is less in the Wichitas. In the Arbuckle Mountains the lower 700 feet of this limestone contains fossils of Upper Cambrian age, while from the upper beds Ordovician forms were obtained.

As has been stated, the hills composed chiefly of this limestone extend practically uninterruptedly northwest from near Fort Sill for 30 miles or more. From the region of Blue Creek Canyon there are two ranges both of which finally die out and disappear beneath the plains. The Arbuckle limestone is an excellent building stone. Along the Blue Creek canyon where a fault has carried the porphyry up alongside the limestone, the latter rock has been metamorphosed and in some places has become a good quality of marble. There is no doubt that in time marble quarries will be located at this point.

In several places there are known to be exposures of asphalt among the limestone hills. Whether or not it will ever be found in paying quantities remains to be seen. Mineral springs are also present.

## VIOLA LIMESTONE.

Three small outlying knobs in the vicinity of Rainy Mountain Mission are thought to be composed of Viola limestone, an upper Ordovician formation, which, in the Arbuckles lies at a level approximately 2,000 feet higher than the Arbuckle limestone. In the Wichita Mountain region little lithologic distinction can be made between the limestone comprising these knobs and the limestone which makes up the main range of hills just described. Mr. E. O. Ulrich, however, who studied the fossils from the entire region, finds that palaeontologic evidence justifies such distinction, and for that reason the rocks comprising the three hills near Rainy Mountain are classed as Viola. It is a good building stone and would make an excellent quality of lime.

With the exception of the limestone in the counties along the Arkansas River in the northeastern part of the Territory, the rock just described are the only limestones in Oklahoma. As the country is more thickly populated these rocks will be used more and more and will in time become a source of considerable revenue.

## CONGLOMERATE.

At the base of all the mountains, whether composed of igneous rocks or limestone, there are considerable deposits of conglomerate, evidently derived from the rocks of which the mountains are composed; that is, at the base of the limestone hills the conglomerate is composed of limestone boulders; at the foot of porphyry knobs the conglomerate is made up of porphyry; while granite or gabbro peaks produce granite or gabbro conglomerate. Near the base of the mountains this conglomerate is composed of rather large pebbles, sometimes as large as a peck measure. On leaving the mountains the pebbles become smaller and more rare, and at the same time the shales in which they are imbedded become reddish in color until at a distance of a few miles from the mountains the conglomerate has changed into typical Red Beds. In some places red shales approach to the very base of the peaks and may occasionally be seen lying unconformably on granite, porphyry or limestone rocks. Mr. Taff's opinion of the conglomerate is as follows:

"It is my interpretation that the conglomerates at the base of the Wichita Mountains are composed of near-shore deposits of the Red Beds and therefore are of the same age, supposed Permian. Of course, you understand that there are considerable surfacial deposits of gravel and sand, especially in the south side of the mountains along the valleys of West Cache Creek which would be classed as Recent." With this conclusion the writer agrees.

## CONCLUSION.

The Wichitas, then, are not excessively high peaks, but, except in a few cases, are low, well rounded mountains composed of igneous rocks of the granitoid type penetrated by dikes of later igneous intrusion. This granite core is flanked on the north by palaeozoic rocks a portion of which have been eroded away in such a manner that these stratified series form an escarpment. Lying next and about the base of the igneous and fossiliferous formations is a conglomerate evidently derived from these formations. About all of these early rocks, and in many places mantling them, are the Red Beds which have come in later geologic times to inundate and submerge the earlier ones. Thus the mountains present to us a scale starting with the igneous rocks, passing through several members of the palaeozoic series, and terminating in those forming at the present time.

# Present Status of the Mining Industry in the Wichita Mountains of Oklahoma.

BY E. G. WOODRUFF.

## INTRODUCTION.

The paper here presented is the result of the writer's investigation on the mine and metalurgical conditions of the Wichita Mountains, of southwestern Oklahoma. The work was conducted as a part of the Territorial Geological Survey, under the direction of Dr. A. H. Van Vleet, Territorial Geologist. The field observations were made during July, September, October, and November, of 1904. The work was undertaken to determine the exact present status of the mining industry in these mountains. In order to gain this information, the writer visited all of the known important workings, and a large number of smaller prospects and claims. He collected information whenever it could be obtained, especially from the miners themselves. In some cases it was found necessary to reject the information of over-enthusiastic prospectors who have become too sanguine from false assays or conditions which they misinterpret. All assays given in this report are from certificates of assayers or from information volunteered by the miners themselves. In no case has the writer substantiated the assays.

## PHYSIOGRAPHY AND EXTENT.

"The Wichita Mountain region consists of a collection of mountains, hills, and knobs extending from Fort Sill, in the Apache Indian Reservation, north-westward to beyond Granite in Greer Co., Oklahoma, a distance of sixty-five miles. From the vicinity of Fort Sill the northern and southern limits of this peculiar collection of mountains, diverge until near the center where the outlying knobs upon each side are thirty miles apart. Continuing northwestward, the range gradually contracts and ends in small collections of low mountains or knobs northwest of the town of Granite. The region is thus symmetrical in general outline, but not so in the arrangement,size, and form of the mountains which constitute the range, or, more properly speaking, the group of mountains. The group of mountains composing the range with one exception, many of the individual mountains and numerous knobs and points of granite and igneous rocks, are surrounded and separated by the nearly level and smooth plain of the 'Red Beds,' which extend southward across Oklahoma into western Texas.*"

## HISTORICAL.

For several centuries, prospectors and adventurers have wandered into the Wichita Mountains. The discovery of old relics of undoubted Spanish origin, points to the work of white men in this region many years ago. It seems probable that a few shallow prospect shafts were sunk, but in general these early explorers confined their operations to the search for placer deposits, in which search they must have failed, since more modern means of investigation have failed to reveal extensive deposits of the precious metals in the sands about the mountains. Thus, the early work was superficial, unimportant, and unsuccessful.

The lack of Indian traditions regarding valuable minerals in these mountains, and the well-known aversion of that race to manual labor, leads to the conclusion that the Red-men did not search beneath the surface for hidden treasures. Such was the nature of the work, with the search gradually increasing, until the early eighties of the last century. In that decade some prospect holes were dug, though then and for a number of years subsequent such work was not permitted by the general government. In 1885-1886 two prospects were sunk in Quartz Mountain, one to a depth of 45 feet, and the other 55 feet. In addition to these, other prospecting was being done, though no other shafts of as great depth were sunk during the ten years from 1880 to '90. From then to the present, prospecting has continued. The Old Entering Wedge, one and a half miles below Roosevelt, experienced some of these early vicissitudes. This company began in 1894 and continued through '95. In '96 the Indian police stopped the work, destroyed the machinery, and burned the buildings. Prospecting continued, however, interrupted by many difficulties other than those presented by nature, to the close of this decade 1890-1900.

On June 6, 1900, the mineral laws were extended over the country, and from then to the present time, the struggle of the miner has been with natural objects on the one hand, and on the other hand, the homesteader who desires the land for agricultural and grazing purposes. The greatest activity in prospecting seems to have been from the summer of 1900 to the middle of 1904. At the present time the activity is decreasing. Whether this is permanent or one of those periodical depressions which comes to all industries, only future developments can tell.

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*Professional Papers, No. 31, U. S. G. S., Page 54.

## MINING DISTRICTS.

The legal mining districts are here discarded, and those which seem to conform to the present customs are adopted. The districts are determined and named from the town about which they group, and from which they draw supplies and mail. Beginning on the north-east is the Meers District, with Meers, the only exclusive mining town in the mountains for its center. Passing south, the Cache District has headquarters at Cache on the Frisco railroad, south of the mountains. West of here the Oreana District conveniently groups about Oreana postoffice. The Cooperton District lies northwest, about Cooperton. Roosevelt is headquarters for the district of that name, though the district is south and west from the town. Wildman is an inland town with a number of shafts in and about it. The Mountain Park District is north-west from that town. Snyder is the center for the south-west mining district. This classification has seemed more convenient than the one legally adopted, and followed in the Federal offices.

## MEERS DISTRICT.

On the east flank of Mt. Sheridan is the Meers Mining camp. It is the headquarters for the operations of this district, which embraces the region about Mts. Scott and Sheridan, with their adjacent valleys. In this district several hundred claims have been staked and a large number of shallow shafts sunk.

At the present time one of the most important works in the entire mountains is Mr. Reemer's test smelter, now almost complete, three miles south-west from Meers. This is a stone structure with a base six and a half feet by eight and a half feet, and approximately twenty feet high, the upper portion is contracted and surmounted by a sheet-iron stack. Within, it is lined to a height of twelve feet with firebrick. From fans, operated by a gasoline engine, pipes lead to each side for the introduction of air, thus producing a forced draft. Coke is the fuel to be used. It is expected that no fluxing will be necessary with this ore. The plant is provided with an assay office. It is expected that this smelter will be in operation before January 1st, '05. Much of the development work in this district is now deferred, awaiting the success or failure of this smelter.

In close proximity to the smelter, Mr. Reemer has a shaft at a depth of eighty-six feet. At this time it is filled to forty feet with water.

The plant of second interest at present, is that of Dr. Hardin, one mile south-east from Meers. This is the most extensive plant in the entire mountains. It represents an expenditure of $19,500 in time and money, $1,800 of which was applied to assaying. The machinery plant, (at a cost of $6,000) consists of one 70 H. P. boiler, with hot water heater, one sinking pump with a capacity of one hundred and fifty gallons per minute, a steam hoist, an air compressor with steel compressed air tank and two sets of drills, circular saw complete with engine for driving it, a gasoline pump at the water plant, and five thousand feet of gas pipe. This machinery is entirely new and complete in detail.

The main shaft of this work is now down one hundred and eight feet, cased with square sawed timbers. The entire plant is now idle, owing to litigation. On an adjoining claim Dr. Hardin has a shaft to a depth of twenty-six feet. He now contemplates deepening this one to two hundred feet during the winter. At ten feet this is reported to have assayed $8.00 in gold and twenty pounds in copper. Another shaft is down twenty-five feet, and is reported to assay $26.00 in gold and silver. Dr. Hardin's asays on the various properties have varied from blank to $105.60. The operations of this property have been much interrupted by litigation.

On the south side of Mt. Sheridan, Mr. Peter Bussjager has a shaft fifty feet deep, in which he is now working. His highest assay reports to be $15.00.

Mr. Myers, two and a half miles south-east from Meers, has a shaft thirty-eight feet deep, in which he is now working. On the north side of Mt. Scott, the O. O. Milligan Mining Co. has a shaft eighty feet deep. The Lone Star Mining and Milling Co. at Meers are down sixty-eight feet. Mr. Allen at Meers has three shafts, one thirty feet, another sixty-five feet, and the third seventy-five feet. None of these last named properties are now being sunk.

In this region there are several hundred claims. A large number of prospects are less than twenty feet deep; some are between twenty and fifty; a few have attained a depth of seventy feet; while several are still deeper. One has penetrated to a depth of over one hundred feet.

Most of the prospects are now idle; two are actually being sunk. Much assessment work has been done, and much more is planned for the coming winter. East from Meers, toward Lawton, assessment work only has been done. Except for a few sample lots, no ore has been shipped from this district.

## CACHE DISTRICT.

This district includes the operations in the Quanah range of mountains, the center of which rests opposite Cache. The eastern portion includes the prospect about Craterville, while the western extremity is terminated by the Patterson prospects.

Ten miles north-east from Cache, on the north side of the range, Mr. Pierson is now sinking a shaft. He has penetrated to a depth of fifty feet. At the bottom of the shaft is a ten foot drift. He reports assays ranging from $2.00 to $36.00. Three men are now employed in this prospect. Operation is by hand, assisted by horse power. No ore shipment has been made.

The Weston Beaver Mining Co., eight and a half miles north-east from Cache has a shaft to a depth of forty feet.

East from here, toward Lawton, no work is being done beyond assessment work. About Craterville are a number of shafts, all of which are abandoned. One is reported to be at a depth of one hundred and six feet. Between Craterville and Cache are several shafts, some of which have a depth of fifty feet. On these no work is being done. Most of these prospects are now flooded.

Five miles north from Cache is the Fullbright mine, now filled with water to twenty-five feet, and abandoned.

In the western part of this district, seven miles north-west from Cache, Parker Brothers are now operating the most famous prospect in this region. At a depth of fifty-six feet this mine is producing galena. It is the purpose of these men to sink this shaft to a depth of one hundred and twenty-five feet during the winter. Two men are now employed. The work is all by hand. One assay of this rock shows it to contain 6.1 per cent of galena. Some of this ore is now at Mr. Reemer's smelter to be used as a flux. With this exception no ore has been shipped.

A quarter of a mile west from Parker Brothers' prospect, are two claims of which Mr. Peterson is manager. One of these prospects is eighteen feet, the other thirty-four feet deep, each is provided with boiler, steam hoist, and steam drills. This machinery is unhoused. One blacksmith shop serves for both properties. These plants are not now operating. One thousand pounds of ore were shipped to Denver, but no returns are avaiable.

One mile east from these prospects is the Black Bear, at a depth of sixty feet. This was sunk by hand. It is now abandoned. Assays are reported at $4.50, $5.00, and $5.25.

Six miles north-west from Cache, Mr. Peter Dike has a prospect thirty-two feet deep. No ore has been shipped, no assays made, no work progressing at present.

The Geronomo Mining Co. has two shafts, one fifteen feet, the other forty-three feet deep. One assay is reported to be $4.80.

Robertson & Steinman, eight miles north-west from Cache, have a shaft at a depth of thirty feet.

On the south side of the mountains are a number of shafts between twenty and forty feet. At one point, a tunnel was driven one hundred and ten feet. All are now abandoned. Thus the Cache district, like all others, contains many claims with prospects varying in depth, mostly shallow, however. One shaft was abandoned at one hundred and six feet, and one tunnel at one hundred and ten feet. The prospects of Mr. Pierson and Parker Brothers, are in actual operation, the former at a depth of fifty feet with a ten foot drift, the latter fifty-six feet direct. The district contains two power equipped plants, both of which are idle. Little development other than assessment work is promised for the near future.

## OREANA DISTRICT.

This district includes the regions north-east of Oreana. It extends eastward to the Cache District, and is terminated at the other extremity by the camps south-east of Cooperton. It contains the deepest prospect now in process of sinking.

The Oreana Mining and Milling Co., two miles east from Oreana, have a prospect now down sixty-five feet. No assays have been made. It is not now being operated. Several shafts near here are between twenty and thirty feet. One has penetrated thirty feet. None are being driven farther. Development here is waiting for the success or failure of other companies.

Two miles north-east from Oreana, Mr. Hale has a copper prospect. This is quite famous in the region, though little real development has been done. The greatest work is an incline of twenty feet. Copper strains are very abundant about this prospect. Assays from twenty-four selected samples give 26 per cent of copper. At present a portion of this property is in litigation.

On the west edge of the Forest Reserve, north-east of Oreana, are a number of abandoned prospects. The Lone Star was sunk to forty-five feet. The highest assay reported was $5.00.

Lee and Paulson's Mill Mine, one quarter of a mile west from the Lone Star, penetrated forty-five feet with assay a little above $5.00.

On the east side of Sugar Tit mountain, three miles east from Oreana (Sec. 11) Messrs. Johnson and Paulson are now sinking an incline. At one hundred and forty feet from the mouth they have not yet cut the lead for which they are drifting. The work is now progressing at the rate of two feet per day. Three men are employed. The work is entirely by hand, the rock being removed in a small car on a tram track. The car is elevated by a hand wince. It is now undecided how far this tunnel will be driven. No assays have been made.

Six miles east from Oreana, Messrs. Clark and Bennett sank a shaft in quartz. The prospect is now filled to fifteen feet with water. This work was done by hand. Progress has now stopped. No reports on the assays were obtained.

The Big Four Company, of Lawton, sank a shaft last year three miles north-east from Oreana. This work ceased at a depth of forty-two feet. In the fall of 1903 a car of ore was taken from this prospect, then at a depth of fourteen feet. The ore was hauled to Cache from which place it was shipped to Denver, Colo. The results of this shipment are not authentically obtainable. Assays from this prospects are said to have been above $100.00.

North-east from Oreana in the west portion of the Timber Reserve, are a large number of abandoned prospects, a few of which were thitry-five feet. One tunnel was driven seventy-five feet.

Three miles north from Oreana, Mr. Love has a shaft between sixty-five and seventy feet. This shaft was driven by hand assisted by a horsepower hoist. The work was carried on during the last summer, but is not now progressing. The shaft contains some water.

In the northern part of this district, are a number of shafts, a few of which are deeper than ten feet, none are below twenty feet.

Most of the operation in the Oreana District is now at a standstill. The incline of Johnson and Paulson is now one hundred and forty feet from the opening, and progressing at the rate of two feet a day. This is the only work in the district now in operation. One prospect between sixty-five and seventy feet, upon which work was recently done, is now at a standstill. Quite extensive assessment work has been performed this last year. There have been no ore shipments during the current year.

## COOPERTON DISTRICT.

This district includes the mountains just east of Cooperton and the first range directly north-west. At the present time there is but one prospect in these mountains upon which more than assessment work has been done.

Three miles north-west from Cooperton is the Oasis mine, in charge of Dr. Hood. This shaft was sunk forty-seven feet. Operation is now suspended. It is expected to continue during the winter. Assays range from $1.26 to $26.00. Beam and Sons of Denver present a certificate showing as follows:

| Number | Gold | Silver | Value |
|---|---|---|---|
| 699 | .20 | .50 | $ 4.25 |
| 446-3 Iron | .30 | 1.50 | 6.75 |
| 446-2 Seam of feldspar | .37 | .50 | 7.05 |
| 446 Rubyfeldspar | .10 | T | 2.00 |
| 404 Selected Small Feeder | 5.25 | 3. | 106.50 |

Average of fine, $25.71.
Average of two highest, $56.77.

## ROOSEVELT DISTRICT.

The Roosevelt District includes a group of prospects south-west and south of Roosevelt, including the workings at Cold Springs. This has been one of the most thoroughly exploited districts in the mountains. It contains a number of shafts, none of which, however, are sinking at this time.

The Alpha property, two and a half miles south-west from Roosevelt, has a shaft forty-five feet deep. It was operated by hand assisted by a horse-power hoist. A small shaft-house covers the opening. The property is not now working; assessment work has been done for this year, and it is expected to resume operations about January 1st, 1905. Mr. Hutton, of Roosevelt, furnishes the information that this company has expended $600 on this property. Assays are reported from $18.70 to $38.50.

The Raven, a few rods north-west from the Alpha, with a shaft twenty-five feet deep, is now abandoned.

Three miles south from Roosevelt, Mr. Parsons has a group of prospects. One near the railroad is now twenty-five feet deep. This shaft is cribbed near the top and provided with a swinging crane above. It is all hand work. No work is now progressing, though it is probably not finally abandoned. One-half mile south-west from here, the Copper King was abandoned at thirty-five feet.

At Cold Springs are a number of shafts, the chief of which is Irons-Leader No. 1, which has a shaft seventy feet deep with a sixty foot drift. Its machinery consists of a steam hoist, a forty-five H. P. boiler, and a steam pump. The machinery is still in place, though the property is not now being worked. The property is provided with a derrick-house and blacksmith shop. At a depth of sixty feet, the average samples assayed $9.00. Nos. 2 and 3 are only prospect holes with ten feet of assessment work on each.

The Culberson Mining Co. No. 1, is located one-half mile south-west from the Cold Springs postoffice. It is now at a depth of eighty feet. The work was sunk by hand with a horse-power hoist. No work is progressing at present. This property is not finally abandoned. No assays have been made. Nos. 2 and 3 are prospects with assessment work only.

About Cold Springs are a number of other prospects of various depths.

In the Roosevelt District as in all others, are a large number of claims with assessment work as the only development. One prospect reaches a depth of seventy feet, from which point a sixty foot drift was driven. This region promises some development during the winter.

November 8, 1903, one car of ore was shipped from Roosevelt, ore coming from the Wildman District, one-third of which was contributed by the Gold Coin, giving reported returns at $9.00, one-third from the Peach Blossom at $14.20, and one-third from The Oaks at $12.00. This ore went to the works of A. M. Beam and Sons of Denver, Colo.

## WILDMAN DISTRICT.

The Wildman District is limited by the Oreana region on the south-east and the Roosevelt section on the north-west. It embraces the prospects in and about Wildman. In this district are a large number of shallow prospects. The Sport Taylor, three miles south-east of Roosevelt, is abandoned at twenty-five feet. In Lightning Gulch, four miles south-east from Roosevelt, is a tunnel twenty-five feet directly into the mountain and an additional twenty-five feet on an angle towards the lead. Approximately $600 worth of work has been done on this property. This same company has fourteen shafts from ten to fifteen feet deep. No work is now progressing. It is expected to do the 1905 assessment work. The total value of work on the Lightning Gulch properties is estimated at $2,200. Assays from picked samples have been $5.20, $8.00, $15, $22 and $23.

One and a half miles north-east from Wildman, Mr. Craycraft has a prospect forty-eight feet deep. The Noolan, two and a half miles from Wildman, is twenty feet deep. Assays are reported at $12 to $18. The Armstrong, just south-east from the Noolan, has a thirty foot shaft. It is now abandoned.

Within the village limits of Wildman, the Gold Coin, twenty feet deep, is not now operating. The Fraction was sunk at a cost of about $400. Assays are said to be about $15. The Lone Jack is abandoned at fifty-seven feet. At fifty feet the Shafer incline ceased. The Post Oak, a twenty-eight foot shaft, is an abandoned prospect one-half mile north-west from Wildman. This is said to have assayed $17.00.

The Free Gulch Mining and Milling Co., has a shaft one and a half miles north-west from Wildman. It was sunk thirty feet at an estimated cost of $175. No work is now being done.

In the Wildman District, development is entirely at a standstill. During 1904 assessment work has continued with but little beyond this. The shafts are shallow, few having attained a depth of fifty feet. There are no deep workings. A large number of claims have been staked. This district has experienced more difficulty from litigation than any other in the mountains.

## MOUNTAIN PARK DISTRICT.

The Mountain Park District comprises the range of mountains extending north-west from the town of Mountain Park. Besides a number of claims and some small prospects, this region contains only three works of note. These are Hallett's, Brewer's, and Poverty Gulch properties.

Hallett's mine, three miles north-west from Mountain Park, is reported to be one hundred and thirty feet deep. No power machinery is employed beyond a horse-power hoist. The buildings consist of a shaft-house, and blacksmith shop. The property is not now in operation, work having been temporarily suspended. No assays are reported.

Three miles north from Mountain Park is Mr. Brewer's prospect, now at a depth of one hundred and thirty feet. Work is temporarily suspended but will resume during the winter. Assays are reported from $1.40 to $2.40, and $3.40. The highest was $6.00 in gold and one and a half ounces in silver.

Poverty Gulch property is four miles north-west from Mountain Park. Work ceased with the shaft at eighty feet. It now contains sixty feet of water. All work was by hand.

In the Mountain Park District no work is in progress. Some is projected for the future. No shipments of ore have been made from this district.

## SNYDER DISTRICT.

The mountains west and south-west from the town of Snyder comprise the Snyder District.

The Meek, Anderson, Laughlin mine, three miles north-west from Snyder, is the deepest shaft in the Wichita mountains. Before abandoned, it attained a depth of two hundred and twenty feet. The work was driven by hand with the assistance of a horse-power hoist. The shaft is now partially filled with water. Assays are reported at from $0 to $8.

One mile north-west from the above is an abandoned shaft thirty-three feet deep.

South-east from Snyder are a few abandoned prospects. One, three miles from Snyder was abandoned at seventy feet. Assays showed from $2 to $10 in gold and two to six ounces in silver. This prospect together with two shallow ones, represents an expenditure of $800. Some prospects, ranging from twenty to thirty feet, are now abandoned. In the Synder District, no work is progressing or contemplated for the immediate future. This district contains the deepest prospect sunk in the mountains, that of Meek, Anderson and Laughlin at a depth of two hundred and twenty feet, but it is now abandoned.

## SUMMARY.

The mining industry of the Wichita Mountains is still in the prospecting stage. A conservative estimate places the number of claims located, at above two thousand five hundred. On many of these claims no work whatever has been done. It is probable that five hundred openings are from ten to fifteen feet deep. The number of shafts ranging between twenty and twenty-five feet does not exceed one hundred. Possibly fifty are more than thirty feet deep. A few have gone beyond one hundred feet, and in one case the shaft was more than two hundred feet deep.

Two cars of ore have been shipped, one from the Wildman District, and one from the Oreana District. In addition to these shipments, a number of sample shipments have been made. At this time, no ore is leaving the region. In one district a small smelter is being constructed to separate the bullion from the gangue.

The difficulty which has existed between the cattlemen and the homesteaders on one side, and the miners on the other, seems to be amicably adjusting itself. The attitude of the Federal Government on the Timber Reserve seems to be indulgent.

A word should be added concerning the damage which unscrupulous assayers have inflicted upon the region. With premeditated purpose they have, in many cases, issued false certificates, thus buoying up hope where it already existed, and creating undue excitement. In many cases the unsuspecting miner has been led to continue his search for the metals in the most impossible places. No one thing has contributed more harm to this industry than have these unprincipled assayers.

Development is now in a quiescent state. At the time this investigation was made, five prospects were actually being sunk, two in the Meers District, two in the Cache District and one in the Oreana District.

In cases where it is proposed to hold the claims, the assessment work for the current year has been completed. There is a promise of a large amount of assessment work in each of the districts, for the following year. Available funds seem to have been almost exhausted so that deep prospecting, except in a few cases, is impossible. Many of the individual miners are now engaged in other occupations to provide sustenance during further prospecting. These are said to be hunting a "grub stake." A few companies have sufficient funds for development.

Prospecting is less active than it was a few years ago. The confidence of those who are still following the pursuit, in ultimate success, does not seem to lessen.

# Report of Mineral Deposits in the Wichita Mountains.

By Edwin DeBarr.

For description of the location and history of the Wichita Mountains geologically, see H. Foster Bain's report on, "Mineral Deposits of Wichita Mountains in Oklahoma," as printed Document No. 149 of the Senate proceedings of the 2nd session of the 58th Congress.

## LIST OF SAMPLES TAKEN.

Nos. 1-2-3, Lost Lead Mine, near Meers Okla.
Nos.4-5, Teddy Mine, near Meers, Okla.
No. 7, The Evening Star Mine, near Snyder, Okla.
No. 8, St. Louis Mine, near Snyder, Okla.
No. 6, Molybdenite rock, (supposed) near Meers, Okla.
Nos. 9-10-11, Brewer Mine, near Mt. Park, Okla.
Nos. 12-13, W. T. Judkins Mine, near Mt. Park, Okla.
Nos. 14-15, Gold Hill, near Snyder, Okla.
Nos. 16-17, Brushy Mount, near Snyder, Okla.
No. 18, Bald Mt., near Snyder, Okla.
No. 19, Harris & Slaukard's Mine, near Meers, Okla.
Nos. 20-25, Ill. Mining Co. on Rattlesnake Mt., near Mt. Park, Okla.
Nos. 26-27, The Ethel Mine, near Meers, Okla.
Nos. 28-29, Miller Lode, near Wildman, Okla.

Nos. 30-31, Honest John, near Wildman, Okla.
Nos. 32-35, Val Verda, near Wildman, Okla.
Nos. 36-38, Homestake, near Roosevelt, Okla.
Nos. 39-40, Timeday Lead, near Timeday Springs, Okla.
Nos. 41-44, Love's Mine, near Oreana, Okla.
No. 45, F. A. Brockman's Mine, near Oreana, Okla.
Nos. 46-47, Gold Hill, east of Wildman, Okla.
No. 48, Lulu Mine, east of Wildman, Okla.
No. 49, Little Frankie, east of Wildman, Okla.
No. 50, Maud S., east of Wildman, Okla.
Nos. 50-55, Alpha, near Roosevelt, Okla.
Nos. 56-59, Twin Rose, S. Wildman, Okla.
No. 60, Oaks Mine, east of Wildman Okla,
No. 61-62, Triplet Mine, near Wildman, Okla.
Nos. 63-64, Gold Coin, near Wildman, Okla.
No. 65, Good Luck Mine, near Wildman, Okla.
Nos. 66-67, Fox Lode, near Wildman, Okla.
No. 68, Peachblossom, east of Wildman, Okla.
Nos. 69-71, Greenhorn, near Roosevelt, Okla.
Nos. 72-74, Mocking Bird Mine, near Snyder, Okla.
Nos. 74-76, Red Cedar, west of Meers, Okla.
Nos. 77-80, Green Lead, west of Meers, Okla.
No. 81, J. W. Catching's Mine, near Meers, Okla.
Nos. 82-83, Yeoman & Mulherin Mine, west of Meers, Okla.
Nos. 84-89, Anderson, Laughlin & Meeks Mine, near Mt. Park, Okla.
No. 90, Grubstake, northwest from Cache, Okla.
Nos. 91-92, Peacock, northwest from Cache, Okla.
No. 93, Accident, northwest from Cache, Okla.
No. 94, Galena, northwest from Cache, Okla.
No. 95, Little Maud, near Snyder, Okla.
No. 96, Big Stone, near Snyder, Okla.
No. 97, Lost Mexican, near Snyder, Okla.
No. 98, Black Hat, near Mt. Park, Okla.
No. 99, near Cold Springs, Okla.
No. 100-106, The Snake, S. W. of Meers, Okla.
Nos. 107-112, M. W. William's Mines, near Meers, Okla.
Nos. 113-117, G. L. Orr's Mines, near Meers, Okla.
Nos. 118-120, Mr. Bain's Mines, west of Cache, Okla.
Nos. 121-123, Mr. Asisman's Mines, E. of Synder, Okla.
Nos. 124-126, the Fullbright Mine, W. of Cache, Okla.
No. 127, J. W. Johnston's Mine, near Meers, Okla.

No. 128, The Mosquito Mine, near Meers, Okla.

No. 129, Deer Jump Mine, near Meers, Okla.

No. 130, Golden Pass Mine, near Meers, Okla.

No. 131-133, W. Glenny's Mine, near Meers, Okla.

No. 134, Buckhorn Mine, near Meers, Okla.

No. 135, Spanish Mine, near Snyder, Okla.

No. 136, Placer washings made by myself south of Brushy Mt., Gold Hill, and Bald Mountain.

Nos. 137-165, Samples brought me by various parties in the mountains.

Nos. 166-197, samples assayed in Dr. S. J. Hardin's office, near Meers, Okla., all of which were assayed in my own laboratory afterwards.

All samples were assayed by fluxes and by the cyanide processes and heavy sulphides were assayed by the chlorination process, and all save No. 136 showed no trace of gold.

No. 136 was obtained from washing placer material south of Brushy, and Bald Mountains and Gold Hill, in the creeks and in Deep Red in which material there is a very small quantity of exceedingly fine gold in a limited area. The lack of water and the black iron in which it is found, together with the limited amount of gold therein, renders it unprofitable for working.

No. 94 showed .98 oz. of silver and 3.6 per cent of lead.

No. 20 contained 5 per cent, No. 21, 3 1-2 per cent, No. 22, 6 per cent, No. 23, 8 1-3 per cent, No. 9, 5 per cent, No. 10, 3 per cent, and No. 11, 3 1-2 per cent of copper.

In collecting and sampling the above ores the greatest care was taken to secure a good sample free from contamination and with a view to revealing the true condition of values for the supposed mineral bearing material. Whenever possible the samples were taken from the shafts and this was the case with samples 1-44; 46-59; 61-67; 69-80; 90-95-97; 136; 166-190.

Nos. 45, 60, 68, 81, 82, 83, 84, 89, 94, 98-106 were taken from the dumps.

Nos. 107-135 were taken in my presence.

Nos. 137-165, 191-197 were brought me at various places without my knowing from whence they came.

# A Preliminary Report on the Building Stone of Oklahoma.

By Eck Frank Schramm.

Oklahoma is abundantly supplied with building material. Besides having an inexhaustible quantity of gypsum for the production of cement, and excellent and accessible shale beds for the manufacture of brick, there are extensive quarries of sandstone, limestone, dolomite and granite scattered throughout the territory. Although the quarrying industry of Oklahoma is only in its infancy, enough has been accomplished along this line, to prove that it is of no little importance from an economic standpoint.

The greater part of the serviceable lime and sandstone of the territory is found in the eastern tier of counties which includes Kay, Noble, Pawnee, Payne, Logan, Lincoln, Pottawatomie, Oklahoma and Cleveland. Considerable sandstone is found in the central and western counties of Oklahoma, but as a rule it is not of sufficient hardness to be of other than local importance. In some localities in this region, however, are deposits of durable sandstone, suitable for ordinary building purposes.

In the Wichita Mountains are immense deposits of granite, gabbro and porphyry, with a limited area of limestone in the northeastern portion of the range. The cost of transportation is a great hindrance to the development of good quarries in this locality. Only a few quarries worthy of mention have been opened in the granite region. No quarries have been opened in the limestone area of the Mountains, with the exception of the one on the Fort Sill Reservation and one or two in the vicinity of Hobart. With adequate transportation facilities innumerable quarries could be opened in the Wichitas. In many places in the mountains conditions are such that short spurs from the main railroad lines could be conveniently run out to where suitable quarries could be established.

## HISTORICAL.

Very little has ever been written in regard to the building stone of Oklahoma. This industry being in an early stage of development, sufficient investigations have not been made to give anything like a comprehensive discussion of the building and ornamental stones of the territory. Lacking the time and adequate apparatus to make the necessary experiments, the writer is obliged to omit all those laboratory invesigations, such as the chemical analysis, strength and durability tests, that would have added materially to the interest of the paper.

This paper will deal for the most part with the locations of the various stone deposits of Oklahoma and descriptions of individual quarries.

For purposes of discussion, the various classes of rocks will be treated in the following order: Under Igneous rocks, granite, gabbro and porphyry; under Sedimentary rocks, limestone, dolomite and sandstone.

## IGNEOUS ROCKS.

The igneous rocks of Oklahoma are of three principal kinds, granite, gabbro and porphyry. These rocks occur in great abundance in the Wichita Mountains.

### GRANITE.

The granite is the more abundant of the three rocks, composing, according to Prof. Gould, nine tenths of all the rocks of the range. Only a few attempts have been made toward developing the stone industry of this region. All of the quarries thus far opened have been in the granite beds. The granite that is being quarried at the present time is used mainly for monumental and building purposes, and to some extent for road and bridge construction. In addition to the above it is being used effectively as a ballast for railroads. For the purpose of railroad bedding this is undoubtedly the best stone in the territory.

The largest and possibly the most important granite quarry in the territory, is located on Quartermaster Mountain, near the town of Granite. It is owned and operated by the Abiline Granite Company. Conditions were particularly favorable for opening and operating a quarry at this place. It is located within a half mile of a railroad and was opened at a place on the mountain side where little work was necessary in order to reach quarryable ledges. The quarry consists of an opening approximately 200 feet long, 60 feet wide and 6 to 8 feet deep. The surface covering consists mainly of rough granite boulders of varying thickness. Immediately below the boulder formation is a heavy bed of fine-grained red granite, from 6 to 8 feet thick. The above ledge was being quarried at the time this record was taken.

The company operating the quarry has established a well-equipped polishing plant, and as the granite is taken from the quarry it goes direct to the plant to be dressed and polished for monuments. This stone takes an excellent polish and is in demand as an ornamental stone. The company has been rushed to supply the demand for dressed granite. The quarry was opened in 1900 and has been in active operation ever since.

## SPRAGUE AND KETTELL QUARRIES.

Other quarries of importance in this vicinity are those owned and operated by W. B. Sprague and W. H. Kettell. The quarries are located about two miles northwest of Granite on the S. E. quarter of Sec. 21, Twp. 6, Range 21 west. The owners in writing of their granite deposits neglected to give the dimensions of quarries and thickness of beds, but stated, however, that stone of any desired dimensions for heavy constructional purposes could be quarried. The greater part of the stone which is being quarried at present is a coarse-grained, gray granite, which takes a fairly brilliant polish. Two other varieties of stone appear in the same quarry, one a coarse, the other a fine-grained red granite. The C. R. I. & P. R. R. have built a short spur from Granite out to these quarries, and are now shipping out heavy dimension stone for use in the construction of abutments and bridges. The R. R. company is also shipping a considerable quantity of rough stone to crushers for ballast. The C. R. I. & P. R. R. Company is using this stone to a considerable extent for road bedding.

## GABBRO AND PORPHYRY.

Large deposits of gabbro and porphyry are well exposed in the north and eastern portion of the Wichita Mountains. Both are hard, compact rocks, and would make good building stone. The gabbro is rather fine-grained and is of a bluish-black color. Locally it is referred to as "Black Granite." The porphyry is a hard compact rock, with a grayish ground mass containing numerous red crystals. No gabbro or porphyry quarries have been opened in the mountains owing to the lack of adequate transportation facilities.

## LIMESTONE.

Limestone is one of the most important stones now quarried in Oklahoma. It is found in two principal localities, one in the northeastern part of the territory, the other in the Wichita Mountain Region. In the first mentioned area are located most of the large quarries of Oklahoma. The northeastern part of the territory is underlain by limestone, extending over the eastern part of Kay County and the western part of the Osage Nation. The rocks of this region are of the Permian and Carboniferous Age. The rocks outcropping all along the hills of eastern Kay County are thought to be the southern extension of the Winfield Concretionary Limestone.

The stone in this locality suitable for building purposes is found to vary widely in different quarries. It is an exceedingly fossilferous limestone with considerable variation in texture and color. The color varies from a white or light yellow to a dark bluish-gray. The lighter colors predominate and are the most extensively quarried. Very little of the bluish-gray stone is being used at the present time. As a rule the stone is quite uniform in color throughout single beds. In certain quarries the stone is of a fine grade, in others coarser and more fossiliferous.

The limestone in this region is used principally for buildings, sidewalks, curbing, road making and bridge construction. It is used also to some extent by the farmers for fence posts, and by stone cutters for rustic monuments. Extensive quarries are located near Newkirk and Uncas, two towns of eastern Kay County.

## DESCRIPTION OF INDIVIDUAL LIMESTONE QUARRIES OF KAY COUNTY.

Some of the more important quarries are those situated along the bluffs of the Arkansas River, two and three miles east and southeast of Newkirk, and those about Uncas. One of the large quarries of this locality is that of J. C. Armstrong, located four miles east of Newkirk on the S. W. quarter of Sec. 22, Twp. 28, R. 3 east. The quarry was opened in 1899 and has been actively operated ever since. The quarry consists of one opening 200 feet long, 50 feet wide and 14 feet deep. It faces the east and has a covering of red shale, varying in thickness from 4 to 10 inches. Immediately under the shale is a boulder formation or irregular layer of stone ranging from 12 to 18 inches in thickness. Underlying this is a thin layer of shale, below which occurs a heavy ledge of white or cream-colored limestone from 8 to 9 feet thick, which can be quarried in blocks of any dimension from 1 to 8 feet square. Beneath this are two layers with a total thickness of 5 feet. The greatest thickness of the upper layer is 16 inches, that of the lower one, from 40 to 44 inches. Beneath this are a few thin strata classed as "Strippings." The stone from this quarry is rather coarse-grained, being very fossiliferous. The 9 foot ledge is more free from imperfections than the other layers and is the one quarried for saleable stone. The stone is of medium hardness and is readily worked by the mason. It is used principally for building purposes and road construction. Locally it is used to considerable extent by farmers for fence posts. Stone from this quarry is being shipped to many points in the surrounding country. The Santa Fe Station at Oklahoma City is constructed from this stone.

During the year 1903, from January 1st to June 1st, 300 cords of dimension stone were shipped from this quarry. The owner, Mr. Armstrong, has equipped his quarry with effective machinery so that dressed stone of any desired dimensions may be obtained at the quarry.

Another quarry in close proximity to the Armstrong quarry, is that of Miles Fuller, located on the N. W. quarter of Sec. 27, Twp. 28, Range 3 east. Here the stone is distinctly bedded, being separated into about five layers, varying in thickness from 6 inches to 4 feet. This quarry consists of one opening approximately 300 feet long, 150 feet wide and 8 to 12 feet deep. In texture this stone resembles that of the Armstrong quarry. The color of the stone varies slightly in different beds, certain layers being almost white, while others have a yellowish or light buff tint. The quarry was opened in 1899 and is only worked at intervals. The stone is sold for rubble, sills, posts, and macadam. The output for 1902 was 150 cords.

## SIFFORD'S QUARRY.

One of the first quarries opened in the vicinity of Newkirk is the one known as the Sifford quarry. It was opened in the spring of 1894, by David Bennett, and has been operated more or less during the succeeding years. It is located 2 miles east of Newkirk on the S. E. quarter of Sec. 31, Twp. 28, Range 3 east. The quarry is about 250 feet long, 200 feet wide and 6 feet deep, having a crescentic or irregular shape and facing north and east. The surface ledge is very irregular in thickness, being in the main a rough boulder formation. The next few layers are greatly broken up and the stone is classed as strippings. A part of these upper layers, however, are of sufficient thickness to be used in walling wells. Beneath this are 5 layers of stone varying from 4 to 12 inches in thickness. This is one of several quarries noted for its excellent flagging stone. Mr. J. A. Skidmore, who operated the quarry during 1903, gives the output for that year between 800 and 900 cords.

## FEAGIN'S QUARRY.

The quarry owned and operated by Jesse C. Feagins is located about 6 miles northeast of Newkirk on the N. E. quarter of Sec. 31, Twp. 29, Range 3 east. The quarry is of irregular shape, being about 250 feet long, 200 feet wide and 6 feet deep. It faces the east and north. The covering consists of red clay and 8 to 10 layers of thin shaly rocks, varying from 1 to 4 inches in thickness. Beneath this appear 2 or 3 heavier ledges ranging from 1 to 2 feet in thickness. The quarry is noted principally for its excellent flagging stone. The owner, Mr. Feagins, supplies most of the local demand for suitable sidewalk stone, besides shipping a considerable amount to neighboring towns. Dimension stone of any size can be secured at this quarry. The stone is of fine texture, having a bluish-white color. The quarry was opened in 1898 and has been operated continuously during the succeeding years.

## BROWN QUARRY.

The quarry owned by C. H. Brown is not far distant from the Feagins quarry, being located on the N. W. quarter of Sec. 5, Twp. 28, Range 3 east. This quarry is 150 feet long, 100 feet wide and 7 feet deep. The covering consists of from one to three feet of clay and shale. Below this occurs the one heavy ledge of stone in the quarry, about 4 feet thick. Beneath this comes a bluish clay 3 feet thick. Underneath the clay occurs a stratum of bluish soapstone of unknown thickness. The stone from this quarry is rather fine-grained and of a bluish-white color, when quarried, but becomes whiter on exposure. It is used principally for curbing and the construction of culverts and bridges. The output for 1903 was 230 cords.

## BAKER'S QUARRY.

Some of the best stone in Kay County for building purposes is taken from the John Baker quarry, located a mile northwest of Uncas, on the N. E. quarter of Sec. 23, Twp. 27, Range 3 east. It consists of two openings, one of which is 80 feet long, 40 feet wide and 9 feet deep. The stripping is about 18 inches thick and increases back of the present face of the quarry. Beneath this covering is a 6 foot ledge from which most of the stone is quarried. Below this is a stratum of blue limestone, possibly 2 feet thick. At the time this record was taken, the quarry-men had not gone below the white stone so that the exact thickness of the blue stone could not be determined.

The second opening is located on the side of a hill about 40 rods to the north of the first. It is nearly twice the size of the first. The stone at this opening is essentially the same as in the adjacent one. with the exception that no blue stratum was found under the heavy ledge of white stone. The white stone is considerably thicker in this than in the other opening, being from 10 to 12 feet thick. Either of these openings could be conveniently extended to a distance of many rods. The stone from this quarry has a uniform texture, a light color, is easily worked, and very durable.

The stone used in the construction of the Santa Fe Station at Shawnee was obtained at this quarry. Mr. Baker has equipped his quarry with all necessary machinery, including an engine, a gangsaw, two derricks, and all the simpler tools necessary for effective work. The quarry was opened in the spring of 1903 and has been continually worked ever since. From 8 to 10 men are employed constantly.

## OTHER QUARRIES.

Only a few of the most important limestone quarries of this locality have been mentioned. There is an inexhaustible quantity of this stone in Kay County, well exposed all along the hills and bluffs of the eastern end of the county. With such an abundance, innumerable quarries have been opened, most of them small, and operated at intervals, simply for local use. Just a few of the larger ones are worked regularly. Among a number of the important quarries of this region that have not been mentioned are the following:

L. J. Robinson quarry, located on the N. W. quarter of Sec. 6, Twp. 27, Range 3 east. The stone in this quarry is found in thin layers, varying in thickness from 1 to 6 inches. Used principally for foundations and side walks.

In the northern part of the county, on the Chilocco Indian Reservation is located a large government quarry, from which is obtained all the stone used in the construction of the Chilocco school buildings. The stone is of 3 colors, a bluish-white, a blue, and a light yellow or cream color. The blue stone is of a finer grain than either of the other two. The light yellow is the coarser grained of the three varieties.

The Atchinson, Topeka and Santa Fe Railroad Company has opened a large quarry near Uncas from which it secured most of the ballast used along the Eastern Oklahoma branch of its road.

This is the only limestone locality in Oklahoma in which the quarrying industry is carried on to any great extent. No quarries are reported in the carboniferous limestone of the Osage Nation and eastern Pawnee County. The heavy ledge of blue limestone which is well exposed in the eastern part of Pawnee County is extremely hard, fine-grained and takes a fairly brilliant polish. It works too hard under the chisel to be of value as a general building stone, but could be used to advantage as a finishing or ornamental stone.

## WICHITA MOUNTAIN REGION.

As previously stated, no quarries have been operated in the limestone region of the Wichita Mountains, with the exception of the government quarry on the Fort Sill Reservation and a few small ones near

Hobart. Limestone is well exposed all along the hills situated northeast of the main range of the Wichitas. Here is abundant stone suitable for constructional purposes and the manufarture of lime. As this part of Oklahoma has only recently been settled, little has been done toward the development of the natural resources of the region.

The quarry on the Fort Sill Reservation has been opened for many years, all of the buildings on the Reservation being constructed from stone taken from this quarry.

A few quarries are in operation in the vicinity of Hobart. No records of these quarries have been secured, but it is understood that they are of sufficient size to supply the demand for local foundation stone.

## DOLOMITE AREA.

Large deposits of dolomite occur in west central Oklahoma. This dolomite is a conspicuous member of the upper Permian of Oklahoma and Southern Kansas. (The geological horizon of this member is fully described by Prof. Gould in the Second Biennial Report of the Territorial Geologist.) The dolomites throughout different localities vary to a considerable extent in texture and color. True dolomites and dolomitic limestone occur in certain localities in Greer and Roger Mills Counties, while in Blaine, Caddo, Kingfisher and Woods Counties are deposits, ranging from magnesian limestone to arenaceous dolomite. The various varieties of dolomite occur in sufficient quantities in any of the above counties to be of considerable economic importance. The deposits which are excellently situated for quarrying are those of southern Blaine, southwestern Kingfisher and northern Caddo Counties. The larger number of quarries are situated in Blanie County in the vicinity of Geary. The stone from these quarries is hard and durable and of a reddish-white color which gives it a rather streaked appearance. Dolomites throughout the region are quarried principally for general building purposes and road construction. In a few places, however, it is burned for the manufacture of lime. A small quarry in the Coyote Hills, east of Geary, is operated exclusively for the purpose of securing suitable stone for the manufacture of lime.

## DESCRIPTION OF INDIVIDUAL QUARRIES.

Most of the quarries in the vicinity of Geary are located near the Coyote Hills three miles east of town and in the Red Hills, 9 miles northwest. Probably the best operated quarries are those situated south and east of Geary. One of the more important in this locality is that of J. W. Boyer, located on the S. W. quarter of Sec. 10, Twp. 13, Range

10 west. The quarry was opened in 1902 and has only been operated at intervals. It consists of one opening 60 feet long, 20 feet wide and 4 feet deep. It has a 12 inch covering of red clay and shale, beneath which are 5 or 6 layers of dolomite varying in thickness from 4 to 6 inches. It is a hard, durable stone, fine-grained, of even texture and of a reddish-white or pink color. Dolomite from this quarry is used for general building purposes and in the construction of bridges and culverts.

## COPELAND'S QUARRY.

Stone similar to that occuring in the Boyer quarry is obtained in the adjacent quarry of Louis Copeland. This quarry is located on the N. W. quarter of Sec. 10, Twp. 13, Range 10 west. It is nearly identical with the one described above, the same number and thickness of beds occuring in both. There are several quarries located in this section, and all are essentially the same.

## DOLOMITE OF CADDO COUNTY.

The dolomite of Caddo County is well exposed about three miles west of Bridgeport along the bluffs of the South Canadian River. No quarries of importance have been opened in this locality. The stone in color and texture resembles that about Geary. The deposits are conveniently located for profitable quarrying, and deserve more attention from local builders than they have yet received.

## SANDSTONE.

Sandstone is more widely distributed over Oklahoma than any other rock occuring in the Territory. It occurs in considerable abundance in every county, although extensive quarries are located in but a few particular localities. There is a wide variation in the texture, composition, durability and color of the different deposits of sandstone throughout Oklahoma.

The color ranges from a white or light-gray to dark-red, and with a variation in hardness from the soft loose sand to the hard compact silicious sandstone. A large percentage of the rocks contains a considerable quantity of iron oxide, consequently the darker colored rocks are abundant.

Sandstone is being quarried and used locally in nearly every county, but only in a few localities is the stone being quarried for shipment to other markets. The best sandstone for building purposes occurs in the eastern part of the Territory, extensive quarries being operated in the vicinity of Ralston, Pawhuska, Perry, Pawnee, Skedee, Stillwater, Chandler, Shawnee, Oklahoma City and Tecumseh. The quarries about Ralston are practically the only ones from which much stone is shipped to other towns.

The sandstone in the western portion of the Territory is of comparatively little economic value, being generally too soft and shaly for building purposes. However, occasional ledges of durable sandstone are found in particular areas. Such ledges occur in northern Caddo, southern Custer, and Roger Mills, and in south central Woodward County. The ledges mentioned in Woodward and Caddo Counties are extremely hard, being undoubtedly the hardest sandstone in Oklahoma. In general, the stone is used for buildings, bridge abutments, culverts, foundation work, sidewalks and road construction. The stone in Caddo and Woodward Counties is especially adapted for heavy constructional work. It is so extremely hard that it is dressed with some difficulty, for which reason it is not in use as a general building stone. In the eastern sandstone area the stone is used for the most part in the construction of buildings. It would be hard to find a town of any size in eastern Oklahoma that has no buildings or business blocks constructed from local stone. Most of the public and Government School buildings throughout this area have been built from local stone, notably the Government Indian School Building, located at Pawhuska, a part of the buldings of the Oklahoma Agricultural and Mechanical College at Stillwater, and the High School building at Pawnee. The ledges from which this stone is quarried are found outcropping along the hills and bluffs of the region, having at times a thickness of thirty feet.

In order to get some idea of the extent of the beds and variety of stone, a few records of some of the more important quarries of this area will be given.

## OSAGE NATION AREA.

The sandstone outcropping in the central and western part of the Osage Nation is of Carboniferous age. In general it is a durable stone of an even texture, fine-grained, and of a yellowish-white color. The only quarries worthy of mention in this area are those located near Pawhuska. The following are records of two of the most important quarries of this region:

### HALE QUARRY.

The quarry operated by J. B. Hale is located on the side of a hill almost three quarters of a mile southwest of Pawhuska. Dimensions, 200 feet long, 60 feet wide and 4 feet deep.

Below a twelve inch covering of shale and clay occurs a three foot ledge of yellowish-brown sandstone. No quarrying has been done below this three foot stratum. The stone when broken from the quarry is rather soft, but hardens on exposure. It is used principally for foundations and buildings. The output for 1902 was 130 cords.

## PALMER QUARRY.

S. S. Palmer's quarry is located one and a half miles north of Pawhuska.

Dimensions of quarry, 150 feet long, 40 feet wide, 5 feet deep. The covering consists of a 6 inch layer of clay. Below this is an 18 inch ledge of soft white sandstone beneath which is a 3 foot ledge of hard, yellowish white stone. This is the ledge which is quarried most. The 18 inch bed of soft stone, on being exposed for some time, becomes durable enough to be used for building purposes. The output for 1902 was approximately 100 cords. The quarry is worked only at intervals.

## PAWNEE AREA.

Some of the largest quarries in Pawnee County are located in the vicinity of Ralston. The stone in this region outcrops along the streams and hills a few miles west of town. It is a durable stone, fine-grained, easily worked, and of a yellowish-white color with numerous dark-brown spots, giving it a rather mottled appearance. The dressed stone has a very pleasing color. Owing to its fine texture, durability and pleasing color, it is sought by builders of some of the larger towns of the Territory for finishing stone.

The quarry owned by J. W. Lamberson of Ralston is representative of the numerous quarries in this region. This quarry is located on the N. W. quarter of Sec. 34, Twp. 24, Range 5 east. It faces the northeast, has a length of 300 feet, a width of 200 feet, and a depth of 4 1-2 feet. The first ledge is 18 inches thick. Beneath this occurs a thin layer of flagging stone about 1 1-2 inches in thickness. Below this is a 2 inch layer of shale, under which occurs a 14 to 18 inch bed of mottled sandstone. A blue clay of unknown depth occurs below this heavy ledge. The quarry was opened in 1903 and has been actively operated ever since. The yearly output is approximately 500 cords. It is sold to local builders for $2.50 a cord.

## CATLETT QUARRY.

The quarry owned and operated by A. Catlett is located a mile east of Pawnee on the N. W. quarter of Sec. 34, Twp. 24, Range 5 east. The stone in this quarry differs from that of the Ralston stone only in color. It is of fine grain, and of a light color. Dimensions, 200 feet long, 20 feet wide. It has a 6 foot covering of bluish shale. Below this occurs a heavy bed of white sandstone nearly 20 feet thick. Many of the business blocks of Pawnee are constructed from stone taken from this ledge. In and about Pawnee are conspicuous ledges of hard red sandstone. A number of quarries have been opened in the red sandstone area of this region, but the writer was unable to secure records from any of the quarry owners.

## PAYNE COUNTY AREA.

The quarry industry has been considerably developed near the towns of Stillwater and Cushing. Near Stillwater both red and white sandstone quarries are being operated for local use. Possibly the largest quarries in the county are those located near the town of Cushing. One of the largest in that locality is owned by Hopkins Brothers. It is located on the N. E. quarter of Sec. 1, Twp. 17, Range 5 east. The quarry faces the north, is 260 feet long, 80 feet wide and 4 feet deep. It has a six inch covering of soil, below which are three ledges of stone, varying in thickness from 10 to 15 inches. Beneath this is a blue clay of unknown thickness. The stone from this quarry does not differ essentially from that found in the Ralston quarries, having about the same hardness, and the same mottled color. Most of the stone used for building purposes in Cushing is supplied by this and neighboring quarries. The Hopkins quarry was opened in June, 1903 and has been in operation ever since. The average output per month is 80 cords.

## SANDSTONE OF SOUTHEASTERN OKLAHOMA.

The sandstone of the southeastern part of the territory in Lincoln, Pottawatomie, Oklahoma and Cleveland Counties, is softer and of a darker color than that occuring in the northeastern counties. A large part of the stone quarried in Cleveland and Oklahoma Counties is too soft to be of much use as a building stone. However, in a few localities in each county a red sandstone, suitable for use as foundation stone, is quarried.

The quarries of Lincoln and Pottawatomie Counties are located near Chandler, Stroud, Shawnee and Tecumseh. The sandstone about Chandler is principally red and white, having a texture similar to that found in Payne County. One of the important quarries near Chandler is owned by P. F. Sennett, located on the N. E. quarter of Sec. 4, Twp. 14, Range 4 east.

Dimensions, 100 feet long, 75 feet wide and 9 feet deep. Back from the present face of the quarry the covering is about 5 feet thick.